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ABSTRACT

The course outline has been prepared to assist the student in learning the basic skills and safety for shaper and milling operations. The course presents the various types of machines, work holding devices, cutting tools and feeds and speeds, and instruction designed to enable the student to obtain the manipulative skills and related knowledge necessary to understand and use correctly the machinery and tools. A three-page bibliography is included, and a 15-page posttest with answer key is appended. (Author/AJ)

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

V-178

Course Outline
MACHINE SHOP WORK 2 - 9555
(Shaper and Milling Machine Operation)
Department 48 - Quin 9555.04

CE 001 949

DADE COUNTY PUBLIC SCHOOLS
DIVISION OF INSTRUCTION • 1973

ED 095376

D A D E C O U N T Y P U B L I C S C H O O L S

1 4 5 0 N O R T H E A S T S E C O N D A V E N U E

M I A M I, F L O R I D A 33132

Course Outline

MACHINE SHOP WORK 2 - 9555
(Shaper and Milling Machine Operation)

Department 48 - Quin 9555.04

county office of

VOCATIONAL AND ADULT EDUCATION

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Dr. E. L. Whigham, Superintendent of Schools
Dade County Public Schools
Miami, Florida 33132

April, 1973

Published by the School Board of Dade County

Course Description

9555	48	9555.04	Shaper and Milling Machine Operation
State Category Number	County Dept. Number.	County Course Number	Course Title

This quinmester course enables the student to acquire the techniques and knowledge needed to operate the shaper and milling machines. The various operational skills are developed as the student works on projects designed to promote the best machining methods. This is the fourth quinmester course to be taken in the first year of vocational machine shop.

Indicators of Success: Prior to entry into this course, the student must display mastery of the skills indicated in Metalworking Lathe (9555.03).

Clock Hours: 135

PREFACE

The following quinmester course outline has been prepared to assist the student in learning the necessary basic skills and safety for shaper and milling machine operations. The materials presented are suggestive of the many manipulative skills, practices, and shop theories to be mastered by the student.

Shaping and milling machine operations are of many types ranging from routine production to work of very close tolerances. It is the ambitious and determined student who will, by learning the various types of machines, work holding devices, cutting tools and feeds and speeds, master the skills necessary to become proficient in the operation of the shaper and milling machines.

The classroom instruction includes lectures, demonstrations, individual and group discussion, audiovisual aids and use of instructional and job sheets.

This is the fourth quinmester course in the second year of machine shop. The outline consists of three blocks of instruction which are subdivided into several units each. This course is 135 hours in length.

This outline was developed through the cooperative efforts of the instructional and supervisory personnel, the Quinmester Advisory Committee, and the Vocational Curriculum Materials Service, and has been approved by the Dade County Vocational Curricullum Committee.

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BLOCK

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Care and Maintenance	2
Selecting Speeds and Feeds	2
Machining Operations	2
Setup Operations	2

II. MILLING MACHINE WORK (85 Hours)

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GOALS

The student must be able to demonstrate:

1. Knowledge of shaper nomenclature, safety rules, feeds and speeds, cutting tools, holding devices, and proficiency in flat contour and angle shaping.

2. Knowledge of milling machine nomenclature, safety regulations, feeds and speeds, various appropriate setups, milling cutters, holding devices, milling accessories and proficiency in the operation of plain, angular and contour milling.

SPECIFIC BLOCK OBJECTIVES

BLOCK I - SHAPER WORK

The student must be able to:

1. List the various types of shapers, shaper parts, holding devices, and explain their function.
2. Demonstrate proficiency in grinding tool cutter bits that will be proper for the operation being done.
3. Select and use various tool-holders designed for different shaper operations.
4. Exhibit the ability to care for, operate, and maintain shaper within the safety standards required by industry.
5. Select and align the proper holding device, calculate the ram speed, stroke length, and table feed, and perform the machining operations to the tolerance specified.

BLOCK II - MILLING MACHINE WORK

The student must be able to:

1. List the various types of milling machines, milling machine parts, holding devices, and demonstrate the ability to operate them in a safe proper manner.
2. Select and set up various attachments that are required for the operation he is performing.
3. Select and use the proper cutting tool and holder in relation to the type of milling machine he is using and the operation he is performing.
4. Exhibit the ability to care for, operate, and maintain milling machines within the safety standards required by industry.
5. Demonstrate the ability to perform various milling and other operations on the milling machine within the tolerances specified.
6. Calculate the proper cutter revolutions per minute and desired table feed using formulas, charts or handbooks.
7. Exhibit the ability to select proper cutting fluids and have knowledge of their effects on cutting tools and materials.

BLOCK III - QUINMESTER POST-TEST

The student must be able to:

1. Satisfactorily complete the quinmester post-test.

Course Outline

MACHINE SHOP WORK 2 - 9555
(Shaper and Milling Machine Operation)

Department 48 - Quin 9555.04

I. SHAPER WORK

A. Safety Precautions
   1. Personal
      a. Eye protection
      b. Proper clothing
      c. Jewelry removal
      d. Proper conduct
   2. Work hazards
      a. Mechanical
      b. Materials
      c. Holding devices
      d. Floor area
      e. Cutting tools
      f. Material chips

B. Nomenclature
   1. Types of shapers
      a. Mechanical
         (1) Floor
         (2) Bench
      b. Hydraulic
   2. Length of maximum stroke
   3. Shaper parts and functions
      a. Work head
      b. Ram
      c. Work table
         (1) Plain
         (2) Universal
      d. Driving mechanism
      e. Operating controls
      f. Holding devices
         (1) Vise
         (2) Fixture
         (3) Strap clamp
         (4) Hold downs

C. Cutting Tools and Holders
   1. Tool bit grinding
      a. Rake and clearance angles
      b. Nose radius
   2. Types of cutting tools
      a. High speed steel
      b. Carboloy
      c. Stellite
   3. Tool holders
      a. Swivel head

b. Tool bit holder
c. Direct clamping
d. Extension holder

D. Care and Maintenance
1. Chip and grit removal
2. Proper lubrication
3. Cleaning methods

E. Selecting Speeds and Feeds
1. Ram speed
a. Formulas
b. Charts
c. Handbooks
2. Feeds
a. Materials
b. Finish desired

F. Machining Operations
1. Vertical
2. Horizontal
3. Angular
4. Contour
5. Internal

G. Setup Operations
1. Vise
a. Parallels
n. Hold-downs
2. Table clamping
a. Straps
b. Angle plate
c. "V" block
3. Aligning work vise
a. Indicator
b. Surface gage
c. Solid or combination square
d. Bevel protractor

II. MILLING MACHINE WORK

A. Safety Precautions
1. Personal
a. Eye protection
b. Proper clothing
c. Jewelry removal
d. Proper conduct
2. Work hazards
a. Mechanical
b. Materials
c. Holding devices
d. Floor area
e. Cutting tools
f. Material chips

II. MILLING MACHINE WORK (Contd.)

B. Nomenclature
   1. Machine types
      a. Vertical
      b. Horizontal
      c. Universal
   2. Manufacturers
      a. Cincinnati
      n. Bridgeport

C. Vertical Milling Machine Parts and Functions
   1. Vertical head
   2. Work table
   3. Saddle and knee
   4. Driving mechanism
   5. Operating controls

D. Horizontal Milling Machine Parts and Functions
   1. Overarm support
   2. Work table
   3. Column and knee
   4. Horizontal spindle
   5. Driving mechanism
   6. Operating controls

E. Work Holding Devices
   1. Vis
   2. Fixture
   3. Strap and clamps
   4. "V" blocks
   5. Angle plates

F. Attachments
   1. Universal vise
   2. Dividing head
   3. Rotary table
   4. Slotting
   5. Gear cutting

G. Cutting Tools and Holders
   1. Cutters
      a. Plain
      b. Side
      c. Slitting
      d. Angular
      e. Staggered tooth
      f. Form
      g. Face
      h. Fly
      i. Gear
   2. End mills
      a. Two flute
      b. Multiple flute

c. Ball radius
d. Carboloy
e. Woodruff key
f. Shell

3. Cutting tool holders
   a. Spindle
   b. Collet
   c. Adapter
   d. Arbor
   e. Quick change

H. Care and Maintenance
   1. Chip and grit removal
   2. Proper lubrication
   3. Cleaning methods

I. Selecting Speeds and Feeds
   1. Cutter speeds
      a. Formulas
      b. Charts
      c. Handbooks
   2. Feeds
      a. Materials
      b. Finish desired

J. Use of Cutting Fluids
   1. Effects on material
   2. Effects on cutting tool

K. Machining Operations
   1. Plain
   2. Angular
   3. Multiple cutter
   4. Straddle
   5. Slitting
   6. T-slot
   7. Keyway
   8. Groove
   9. Slab
   10. Gear
   11. Rack
   12. Form

L. Other Operations
   1. Drill
   2. Ream
   3. Bore
   4. Counterbore
   5. Spot face
   6. Center drill
   7. Countersink
   8. Tap
   9. Line scribing

II. MILLING MACHINE WORK (Contd.)

M. Setup Operations
   1. Vise
      a. Parallels
      b. Indicator
   2. Table clamping
      a. Straps
      b. Angle plate
      c. "V" block
   3. Aligning work
      a. Indicator
      b. Surface gage
      c. Solid or combination square
      d. Bevel protractor
      e. Sine bar

III. QUINMESTER POST-TEST

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3. Fundamentals of Filing. 16 mm. 12 min. B/W. Sound. United World Films, Inc.

4. Grinding Cutter Bits. 16 mm. 20 min. Color. Sound. South Bend Lathe Works.

5. Grinding a Parallel Bar. Part I. 16 mm. 14 min. B/W. United World Films, Inc.

6. Hacksaws. 16 mm. 18 min. B/W. Sound. United World Films, Inc.

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A P P E N D I X

Quinmester Post-Test Sample

Quinmester Post-Test

Name _____ Date _____ Score ____

Part I - Shaper

Completion Test Items

A. List ten safety precautions related to the operation or set up of a shaper. Use the spaces provided below.

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

B. Fill in the spaces below with the word or words that will make the statement correct.

1. A workpiece may be held in a shaper for machinery by clamping it directly to the _____ or securing it in the _____.

2. The two types of work table on the shaper are _____ and _____.

3. Under no circumstance should the _____ traverse lever be engaged while the ram is reciprocating.

4. _____ are used between the workpiece and vise bottom to bolster and level it.

5. A type of toolbit other than high speed steel used for shaper work is _____.

Quinmester Post-Test

Name _____ Date _____ Score ____

Multiple Choice Test Items

Each statement needs a word, a figure, or a phrase to make it correct. Only one of the choices listed is correct. Place the letter of the choice you make in the space provided at the left edge of the sheet.

____1. A shaper vise should be:

a. Used on drill press
b. Used for round work only
c. Checked for square before using
d. Clamped loosely until after the first cut
e. Clamped tightly until after the first cut

____2. Before starting the shaper, the operator should be sure that:

a. The lights are turned on
b. His hands are clear from the tool head and work
c. The print for the job is handy
d. He has a stool to sit on
e. The shop is ventilated properly

____3. The shaper is:

a. A machine tool
b. A turning machine
c. A precision tool
d. Used for off hand grinding
e. Used for boring

____4. On a shaper, the length of the work being done determines the:

a. Motor speed
b. Depth of cut
c. Length of stroke
d. Rate of feed
e. Type of lubricant used

____5. The ram of speed of the shaper is measured in:

a. Revolutions per minute
b. Thousandths per inch
c. Strokes per minute
d. Inches per minute
e. Feet per minute

___6. While the shaper is in operation, the operator should place himself:

a. In front of the ram
b. Behind the ram
c. To one side of the ram
d. None of the above
e. At a high point above the machine

___7. Clearance angles or shaper tool bits:

a. Are not important to the life of the tool
b. In all cases are ground to 90°
c. Are ground on the same angle as lathe tools
d. Should be ground properly to prevent drag
e. Are ground with more rake than lathe tool

___8. It is unsafe to use the shaper without knowing something about its operation because:

a. There is danger in overheating the machine
b. The crank handle may fall off
c. The ram will not return properly
d. The rapid travel feed may become disengaged and operator can be seriously injured

___9. The setting of stroke length in shaping requires an amount equal to the length of the stock plus a minimum of:

a. 1/4"
b. 3/4"
c. 1-1/4"
d. 1-3/4"
e. 2"

___10. The terms right handed and left handed as applied to shaper tool bits are derived from lathe tools of similar shape; that is, a right hand is one which is designed to cut from:

a. Top to bottom
b. Left to right
c. Right to left
d. Front to back
e. Left side top to bottom

___11. Given a rectangular block 2" by 3" by 6", which side would you shape first to insure squareness:

a. 2"
b. 3"
c. Either 6" or 3"
d. Either 2" or 3"
3. 6"

____12. Which of the following operations is not likely to be done on the shaper:

a. Shape a keyway
b. Shape a gear
c. Shape a dovetail
d. Shape a flat surface
e. Shape a slot

____13. A shaper listed as 24" size means that:

a. The ram will move through a 24" distance
b. The table is 24" square
c. The ram is 24" long
d. It will hold and machine a block 24" square
e. The vertical height adjustment is 24"

____14. Ordinarily shaper tool bits require a back rake angle of

a. 0°
b. 3°
c. 9°
d. 16°
e. 26°

____15. For general work, end and side relief angles for shaper tool bits are ground at:

a. 1° to 3°
b. 3° to 5°
c. 5° to 7°
d. 7° to 9°
e. 9° to 11°

____16. The rate of cutting speed at which metal may be moved with a shaper does not depend on which of the following factors:

a. Kind of material being machined
b. Depth of cut being taken
c. Length of stroke
d. Kind of cutting tool material
e. Rigidity of machine

____17. Feed as applied to shaper operation refers to the:

a. Ratio between the cutting and return stroke
b. Distance the tool travels on the cutting stroke
c. Rate or time required for the tool to pass over the work
d. Distance the work advances per each ram stroke
e. Rpm of the crank

18. What is the correct formula for determining strokes per minute on the shaper:

a. $N = \frac{C.\ S.\ \times 7}{L}$

b. $N = \frac{C.\ S.\ \times L}{7}$

c. $C.\ S. = \frac{N \times 7}{L}$

d. $L = \frac{N \times C.\ S.}{7}$

e. $L = \frac{N \times 7}{C.\ S.}$

19. The principal use of the shaper is to machine:

a. Slots
b. Keyways
c. Irregular surfaces
d. Gear teeth
e. Flat surfaces

20. Before mounting work, it is advisable to remove all chips and burns from the work holding device so as to prevent:

a. Damage to rise jaws
b. Tool breakage
c. Rise breakage
d. Misalignment of work
e. Marring of work

Quinmester Post-Test

Name _____ Date _____ Score ____

Problem Solving

The following three problems will require the use of the table below. Examine the table for the recommended cutting speeds in order to calculate the strokes per minute.

Cutting Speeds for Shaper

Machine Steel	100 C. S.
Tool Steel	60 C. S.
Cast Iron, Soft	70 C. S.
Brass	200 C. S.

Formula for Number of Strokes Equals $\frac{\text{Cutting Speed} \times 7}{\text{Length of Workpiece}}$

Calculate the number of strokes for the following. To receive full credit you must show all work.

1. Soft cast iron - 10 inches long

2. Brass - 20 inches long

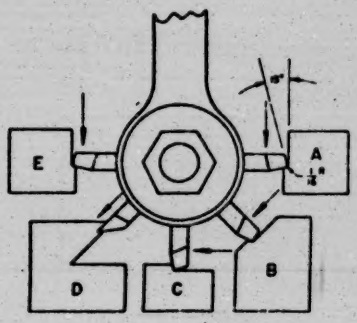
3. Mild steel - 5 inches long

Quinmester Post-Test

Name _____ Date _____ Score ____

Identification Test Items

A. Examine the type of cuts illustrated by the swivel head holder in the figure below. Write the letter of each cut position in the numbered blanks preceding its description in the spaces provided to the right.



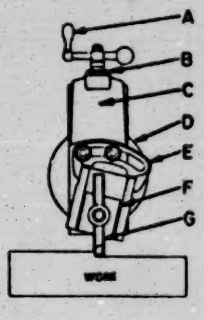
____ 1. Horizontal

____ 2. Angular

____ 3. Vertical

____ 4. Angular dovetail

B. Examine the lettered parts of the tool head assembly shown in the figure below. Write the letter of each part in the numbered blanks preceding their correct names in the space provided to the right.



____ 1. Tool slide

____ 2. Down feed handle

____ 3. Hinged clapper block

____ 4. Apron

____ 5. Tool bit

____ 6. Graduated feed screw dial

____ 7. Graduated head swivel base

Quinmester Post-Test

Name _____ Date _____ Score ____

Part II - Milling Machine

Completion Test Items

A. List ten safety precautions related to the operation or set up of a milling machine. Use the spaces provided below.

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

B. Fill in the spaces below with the word or words that will make the statement correct.

1. Milling cutters are located and driven on an _____ which is attached to the spindle of a milling machine.
2. The name of the taper on the cutter holding device is _____ _____.
3. Two manufacturers of milling machines are _____ and _____.
4. A gear may be defined as a wheel with _____.
5. The main purpose of a gear is the _____ of power.
6. When selecting a milling cutter to use, the operators must know the _____, _____, _____, and _____.

Quinmester Post-Test

Name _____ Date _____ Score ____

True-False Test Items

Each of the following statements is either true or false. If the statement is true, draw a circle around the letter T following it; if the statement is false, draw a circle around the F. If a statement is false in part, it is entirely false.

1. If necessary, work may be clamped to the table of the milling machine in order to perform an operation. T F

2. The rapid traverse lever on the milling machine can be used to make the machine cut faster. T F

3. The feed of a milling machine is dependent upon the speed of cutters. T F

4. The woodruff cutter is used to cut keyways. T F

5. Fixtures are used in many ways for milling machine work. T F

6. The bed type milling machine has a vertical spindle. T F

7. The most commonly used type of gear is the bevel gear. T F

8. The direction of work being fed against a milling cutter running clockwise should be from left to right. T F

9. A staggered tooth cutter is more efficient to use as it dissipates heat faster and clears chips more readily. T F

10. The dividing head is used for gear cutting only. T F

11. Forty turns of the dividing head crank rotates the spindle one complete revolution. T F

12. Eight turns of the dividing head crank rotates the spindle 72^{o}. T F

13. The causes of most inaccurate work done on the milling machine are chips and burrs. T F

14. As a general rule, larger cutters should run slower than smaller milling machines. T F

15. The most accurate way to align a vise on the milling machine is with the use of an indicator. T F

Quinmester Post-Test

Name _____ Date _____ Score ____

Multiple Choice Test Items

Each statement needs a word, a figure, or a phrase to make it correct. Only one of the choices listed is correct. Place the letter of the choice you make in the space provided at the left edge of the sheet.

____ 1.. What kind of machine tool functions by rotating a multitooth cutter against a workpiece mounted on a traversely fed table:

a. Planer
b. Milling machine
c. Shaper
d. Drill press
e. Lathe

____ 2. In milling machine structure a "plain" differs from a "universal" because it lacks the feature of:

a. Dividing head
b. Column swivel
c. Knee traverse
d. Rotary table
e. Spiral milling attachment

____ 3. Which type of milling machine is especially suitable for precision, hole machining operations:

a. Vertical
b. Horizontal
c. Universal
d. Plain
e. Bed

____ 4. The only type of milling that can be safely and effectively done on a machine lacking the antibacklash feature on its table feed screw is:

a. Down milling
b. Standard cut milling
c. Climb cut milling
d. Conventional milling
e. Universal cut milling

____ 5. Which of the following is generally not a factor in specifying milling machine type:

a. Horsepower rating
b. Longitudinal
c. Plain, universal, vertical, etc.
d. Weight
e. Model designation

____ 6. The part of a milling machine from which the arbor receives its drive is the:

a. Overarm
b. Pulley
c. Column
d. Saddle
e. Spindle

____ 7. The distance a cutter travels along the face of the work during one complete revolution about its axis is called:

a. Pitch
b. Rpm
c. Lead
d. Feed
e. Cutting speed

____ 8. What milling accessory is used for obtaining equally spaced divisions on the periphery of work such as gears, drills, shafts, etc.:

a. Index attachment
b. Spiral milling attachment
c. Slotting attachment
d. Rotary attachment
e. Table setting attachment

____ 9. There are four classifications of milling cutters which derive their names from operations they perform. Which of the following is <u>not</u> one of these classifications:

a. Plain milling
b. Face milling
c. Form milling
d. Angular milling
e. Vee milling

____10. What type of mill cutter is designed for slabbing or surface cuts:

a. Ball
b. Two flute
c. Three flute
d. Multiple flute
e. Shell

____11. A type of cutter used for machining brass or aluminum is:

a. Half side cutter
b. Slotting cutter
c. Shell cutter
d. Fly cutter
e. Form cutter

____12. The self-releasing taper adopted as the Standard Natural Milling Machine taper has a taper of:

a. 3-1/2" per foot
b. 4-1/2" per foot
c. 1/2" per foot
d. 5/8" per foot
e. 2-1/2" per foot

____13. A cutting fluid used in milling work does not contribute directly to which of the following:

a. Flushing away chips
b. Reduced cutter wear
c. Better surface finish
d. Preventing chip to cutter adhesion
e. Prolonging cutter life

____14. Which of the following conditions is most likely to result if an arbor nut is tightened or loosened without the arbor support in place:

a. The spindle bore will be damaged
b. The cutter will slip
c. The threads will be stripped
d. The arbor will be sprung
e. The arbor key will be sheared

____15. At the heart of the dividing head is a single thread worm gear containing:

a. 10 Teeth
b. 20 Teeth
c. 40 Teeth
d. 60 Teeth
e. 80 Teeth

____16. The part on the dividing head which allows the operator to omit the counting of holes and spaces each time he indexes is called the:

a. Sector
b. Dividing arms
c. Index crank
d. Counter
e. Divider

____17. When indexing requires more or less than whole turns on the index crank, it becomes very important that the operator accurately count the turns and:

a. Spaces
b. Holes
c. Sectors
d. Index plates
e. Crank rpm

____18. The type of index head most commonly used in machine shop is:

a. Spiral index
b. Plain index
c. Universal index
d. Starret index
e. Helicap index

____19. Removing the plunger pin at the back of the index plate is necessary for:

a. Compound indexing
b. Simple indexing
c. Angular indexing
d. Multiple indexing
e. Direct indexing

____20. One turn of the index crank rotates the head:

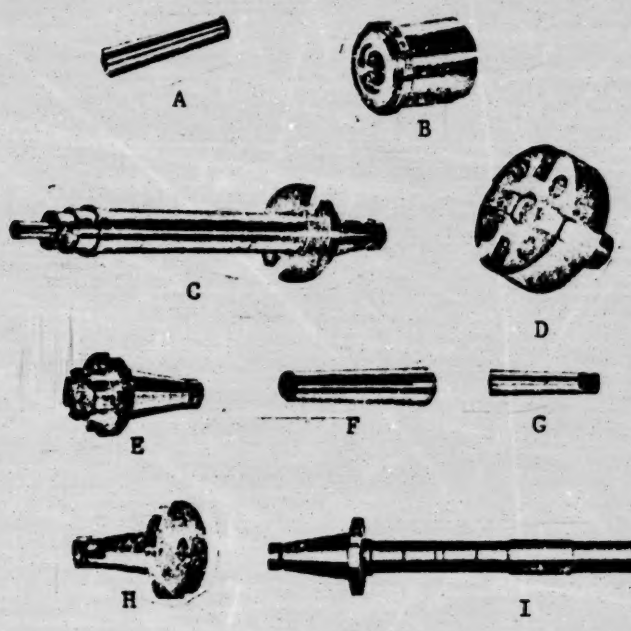
a. 18^{o}
b. 4^{o}
c. 9^{o}
d. 21^{o}
e. $9\text{-}1/2^{o}$

Quinmester Post-Test

Name _____ Date _____ Score ____

Identification Test Items

A. The mounting of a wide selection of standard and special type milling cutters is possible with various arbors, collets, and adapters. Write the letter of each part in the numbered blanks preceding their correct names in the space provided.



____ 1. Reducing collet

____ 2. Arbor adapter

____ 3. Collet adapter

____ 4. Split collet

____ 5. Solid collet

____ 6. Shell end mill arbor

____ 7. Arbor, Style A

____ 8. Bushing

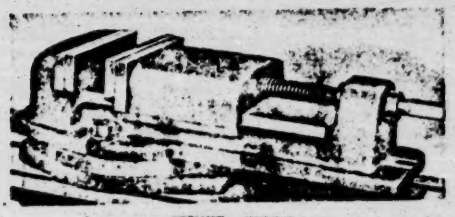
____ 9. Arbor, Style B

B. Write the letter of each of the illustrated workholding vises in the numbered blanks preceding their correct names in the space provided.

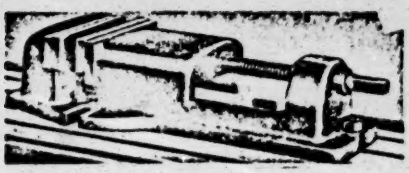
____ 1. Plain type

____ 2. Universal type

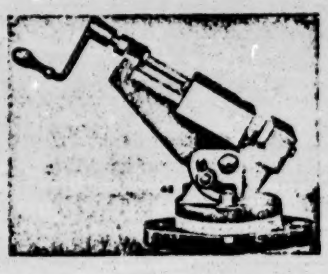
____ 3. Swivel type



A



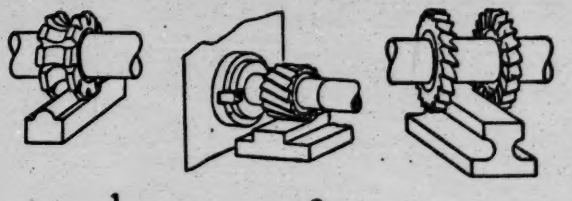
B



C

C. Match the lettered "milling cutters" with the numbered "job applications." Place the letter of the cutter used for the illustrated job application in the blank provided.

Job Applications

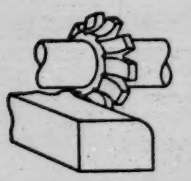


_____1.

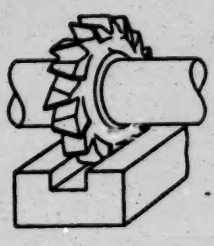
_____2.

_____3.

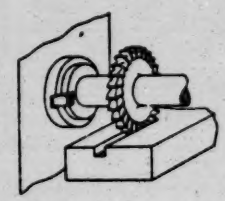
_____4.



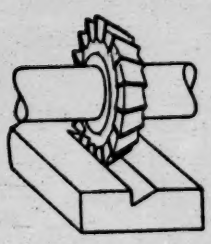
_____5.



_____6.

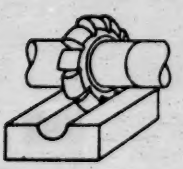


_____7.



_____8.

_____9.



_____10.

Milling Cutters

A.

B.

C.

D.

E.

F.

G.

H.

I.

J.

ANSWER KEY TO QUINMESTER POST-TEST

Part I - Shaper

Completion

A. Instructor to check answers

B. 1. Table, vise
2. Plain, universal
3. Rapid
4. Parallels
5. Carboloy or stellite

Multiple Choice

1. c	8. e	15. b
2. b	9. b	16. c
3. a	10. c	17. a
4. c	11. e	18. a
5. c	12. b	19. e
6. c	13. a	20. d
7. d	14. a	

Problem Solving

1. 49
2. 70
3. 140

Identification

A. 1. C
2. B
3. A
4. D

B. 1. C
2. A
3. F
4. E
5. G
6. B
7. D

Part II - Milling Machine

Completion

A. Instructor to check answers

B. 1. Arbor
2. Brown and Sharpe
3. Cincinnati, Bridgeport
4. Teeth
5. Transmission
6. Outside diameter, inside diameter, type, thickness

True-False

1. T	5. T	9. T	13. T
2. F	6. F	10. F	14. F
3. F	7. F	11. T	15. T
4. T	8. T	12. T	

Multiple Choice

1. b	6. e	11. d	16. a
2. b	7. c	12. a	17. b
3. a	8. a	13. c	18. b
4. d	9. a	14. d	19. e
5. b	10. e	15. c	20. c

Identification

A. 1. E	4. B	7. A	
2. H	5. F	8. C	
3. G	6. D	9. I	
B. 1. B	2. C	3. A	
C. 1. J	5. I	9. B	
2. E	6. H	10. A	
3. F	7. C		
4. G	8. D		